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Narrative Science and Narrative Knowing. Introduction to a special issue on Narrative in Science

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1. Introduction

Why does a natural historian tell narratives about ant-lions? How does the medical profession gain knowledge from case narratives? Why does a physicist trace a mathematical simulation as intently as an author tracks the interactions of characters in a novel? Why does mechanistic thinking about international confrontations only become coherent when made sense of by the accompanying narrative? Why do narrative possibilities loom larger than narrative actualities in some scientific sites? Is narrative the place for situating evidence, or a vehicle for re-situating concepts? How does narrative sometimes become the way of bringing things together, and other times become the medium for unfolding or revealing the path of events? How does narrative at some sites integrate chunks of mathematics, at other sites act to fill in gaps between bits of mathematics, and in other places prove complementary to mathematics? How do narratives explain in science, if indeed they do?

All these hard questions, and more, arise in, and from, the papers in this special issue of *SHPS-A*, which are dedicated as much to putting these questions on the agenda as they are to answering them for their own specific sites and in their own specific ways for the history and philosophy of science.

The role of narrative in the sciences has been neglected for too long, as evidenced by these papers devoted to the subject, for the questions they raise quickly grow from site specific ones into generic ones, with broader scope across a sufficient number of instances to be put properly on the table as legitimate questions for historians and

philosophers of science. Indeed, these look hard enough questions to keep a bevy of us occupied for several years and through many papers.

Until now, philosophers of science have not given narrative much credence as having any epistemological functions and, if anything, have been deeply suspicious that it could have any such functions. They have sometimes used narrative case studies from the history of science, and very occasionally commented on their role in their philosophical arguments, but they have not seriously taken up any questions about the use of narrative in science by scientists. By contrast, philosophers of history take narratives for granted but have been much exercised about their role. Their arguments during the last decades have focussed particularly on the way that narratives serve an explanatory function in history. Roth (in this special issue) makes a strong philosophical argument based on the idea that historical conclusions are not detachable from the narratives that produce them. This implies that narratives can only explain in the particular context of their usage and only through retrospective analysis. How far this approach to history can be adapted to the narratives of science is unclear. For example, there is some interesting tension here with Beatty's account (this issue) of contingencies and nodal points in the histories of evolution (though no fundamental disagreement about whether narratives explain). Regardless of these arguments, it is true that these philosophical debates have largely passed historians of science by, who have happily constructed narratives about scientists, and about their sciences, oblivious for the large part to the terms of that broader debate in philosophy of history. In addition, historians of science have often ignored the way that their subject scientists use narrative in their work, to the extent that perhaps the best known study of scientific narratives is by a literature specialist (Beer, 1983). Historians of science apparently have not thought scientific narratives important, and in most fields perhaps they have not even noticed the narratives that their actors wove and told about their subject matters.

As the questions above suggest, the papers in the special issue cover an open terrain from narratives about ant-lions to the possibilities of narrative explanation. Some of our papers are unashamedly philosophical, others outright historical, and others provide cross-overs between history, philosophy, and the literature of science, for we cannot study narratives by ignoring rhetorical and literary matters. Our introduction picks out several important narrative themes that have broad scope, and that are expressed in these papers either specifically about a science or generically about a problem. At the same time, we point out how these papers are provocative in knocking aside some oft-made, simple, or stereotypical, assumptions about there being a fundamental opposition between narrative and science, as in the classic formulation of Hempel on explanation necessarily depending on deduction from laws. Our introduction aims to show how the papers speak to each other and to critical questions in history and philosophy of science about what narratives do for the scientists who use them, whether in a natural or a human or a social science.[1]

2. Coherence Making and Unfolding in Time

The papers in this issue draw out two quite basic ways in which narratives function in the sciences. Not surprisingly, they feature as two prominent virtues of narratives in the literature on narrative. The first is that for some scientists, or at some sites of science, narrative works to create coherence between a variety of different elements that otherwise do not appear to hang together, but do need to be made to fit sensibly together whenever an investigator recognises that they are all elements that belong to the phenomenon to be described or explained. Sometimes in science this variety of stuff consists in chunks of evidence from different sources and of different kinds and the narrative serves to situate them in relation to each other. Sometimes

[1] This introduction does not pretend to offer a literature survey of the work on narrative that appears in philosophy of history, narrative studies and, more thinly, in history and philosophy of science. Relevant references both to these generic categories of literature and to specific studies for the particular sciences, are given in the papers of the special issue.

the heterogeneity involves different pieces of theories or different conceptual elements. The fitting together can be thought of as a process of coherence making, of showing how disparate elements interrelate, so as to make an account that is coherent in itself, and is consistent with all the bits of scientific stuff on the table, perhaps reaching for integration or synthesis (Morgan, this issue). Sometimes the construction of the narrative serves to show gaps in evidence that might then be filled through the search for further evidence (Currie and Sterelny in paleoanthropology, this issue). Other-times, the stitching together of the narrative offers the scientist a process to figure out where and why the different explanatory devices and situational elements fit together, knowing that they need to be aligned to make any kind of joined-up account of the matter (Crasnow in political science, this issue). At still other-times, there is a combination - a process of throwing out and taking in both possible explanations and shards of evidence during successive re-descriptions in order to make a fruitful fit between the scientist's projections and their experience, as in medical diagnosis (Hurwitz, and see Ankeny, 2011). Narrative then provides a natural form for bringing related elements into order or creating order out of dis-ordered materials which can be brought into connection with each other (Morgan's account of social anthropologycommunity studies, this issue).

The second prominent way in which many of our papers show narrative functioning in the sciences, concerns its use in making things known and understandable by revealing how, like a story, they "unfold" in time. This is sometimes done by tracing processes backward in time (Roth, this issue). This can reveal twists, turns, and contingencies, paths not taken, opportunities forgone, even moments of regret (Beatty, this issue). Or it can be done by following forward the processes by which things do unfold in time towards a denouement (Wise, this issue). Both forward following, and backward tracing reveal narrative paths that are neither fully predictable nor fully explainable, yet create narrative accounts that are themselves a source of illumination to the scientist (Wise, Beatty, this issue). Here again narrative provides a natural format for describing development and change

through time, with later states unfolding from earlier ones in sometimes convoluted paths. These are features that fit the basic sense and definition of what a narrative is and does. This function of narrative is particularly apparent in the case of complex systems, whether describing specific physical processes (the growth of snowflakes, see Wise 2011) or broad historical developments (industrialization), in which multiple factors interact and no overarching theory can predict exactly what will happen.

We must stress immediately, however, that although narrative provides a natural form for both coherence making and unfolding in time, and indeed may be irreplaceable in some areas (Roth on history, this issue), its value should not be thought of as limited to situations where theory is less than effective. Having a relevant theory does not substitute for having a rich narrative and having a good narrative may well embed a relevant theory: the two forms are not exclusive and may well reinforce each other.

3. Possibilities and Counterfactuals

Narrative's irreplaceability for certain domains of science suggests another of the great assets of thinking and reasoning explicitly in such a form. In the context both of coherence making and temporal unfolding, a narrative account makes it easy to think not just about contingencies, but about possibilities, and counterfactuals. Narratives deal in these characteristics routinely. By contrast, the notions of determinism and indeterminism, which so firmly shaped past discussions of explanation using scientific laws in the philosophy community, seem in this framework unhelpful to say the least. Rather, the explanatory power of narratives lies in being able to chart a satisfactory path not just through contingencies, possibilities and alternatives, but to do so by making active use of those features. The fact that these characteristics of narrative are taken to be routine opens up the discussion of scientific explanation

into more sophisticated directions. Because these possibilities in narratives arise from considerations of the paths taken and not taken, they enable assessments of the critical junctions or nodes in the path. The alternatives at each nodal point may be rather limited, equivalent to those faced by a participant in an historical event, or character in a novel, but sometimes in science these nodal points may offer many possibilities and many framings. Where situations are highly constrained by many factors, the scientific narrative will likely pay deep attention to those nodal points of decision, the possible alternative narrative paths they prompt, and the outcomes of those paths, to see why some paths offer more plausible accounts of outcomes than others (Crasnow, this issue). Where there are multiple possibilities, and multiple possible paths taken and not taken, as in evolutionary biology, that attention is required to figure out which nodal points really mattered in re-playing the narrative tapes of the scientific problem at issue (Beatty, this issue). Paying deep attention may require a serious search over those alternative paths, with explicit regard to the counterfactuals and their attendant possible outcomes. In all of these cases it is consideration of how a process might have been different, under different conditions and with different consequences, which illuminates the path that was taken, or indeed the multiple paths that have been taken in view of the variety of events and outcomes found for example, in evolutionary biology as much as in social anthropology.

4. Mathematical Models and Narratives

It is at this point, where we have recognised that narrative is associated with multiple possibilities, that we can recognise a more surprising link found in the scientists' toolbox, namely between the use of mathematical models and narratives. Mathematical modelling and narrative presentation are often presumed to be antithetical: that is, a person deals in one or the other way of reasoning. But, in

practice, scientific work is not so dichotomous. Very often mathematical models and narratives function together and are complementary in a variety of ways. Use of a mathematical model may be accompanied by a set of narratives that explore the logical implications of the model in answering a set of questions, or an alternative set of parameter values: each new set-up starts a chain of reasoning using the interrelations of the elements in the model, thus enabling the scientist to explore the character and the identity of a theory instantiated in the model (see Morgan 2001, 2012). A similar model-narrative interrelationship appears in simulations of systems whose complexity defies an approach through a nicely unified mathematical model that is analysable in itself. Running the simulation repeatedly while adjusting components and parameters in the model, can facilitate creation of an increasingly comprehensive narrative describing the process being simulated. Even subtle variations in the model can lead to different paths of development and thus different narratives. Where the simulation possibilities seem almost infinite, as with some models, it is the function of narratives to reveal those possibilities that provides the narrative payoff. In these cases the world is better represented, and better grasped, by exploring the mathematical model and the possible narratives in interaction than through either alone (see Wise on snowflakes and chemical bonding, (2011) and this issue). Even when mathematical solutions are available, accompanying narratives provide additional understanding, for they capture the process and its possible range in a way that abstract formalism cannot.

A rather different function that narratives fulfil in some circumstances is to provide the umbrella account in which mathematical elements also feature. It is not just that the narrative fills in gaps that occur between different chunks of mathematics (though it may do so) but that it plays a stronger function as the overall integrating device which joins together those bits of mathematical modelling appropriate for separate parts of a process (see Rosales on evolution, this issue). Another complementary functional usage occurs when the narrative is used as the matching

device that enables scientists to map the mathematical elements of their theory or causal mechanism onto the events and situations in the world: narratives offer the flexibility to provide a trial and fit activity (Morgan 2007). In still other situations, a mathematical model and a narrative may act in opposing but complementary ways, with the model providing a more precise but more limited perspective and the narrative a more informal but broader one (Currie and Sterelny on paleoanthropology, this issue).

5. Causality and Temporality

Very often these complementary usages of mathematical models and narratives rely on, or build upon, an appeal to ambiguity about causality and temporality in giving accounts of the scientific phenomena at hand. Perhaps the deepest reflections coming from these papers on narrative in science are those that rely on these ambiguities to challenge the notion and character of narrative as a category. The two most basic ideas among narratologists are a) that a narrative gives an account over time, and b) that a narrative is not a chronicle - not a mere sequence in time - but concerns connected elements. Beyond that, subdivisions of definitions abound, based on events, beginnings-middles-ends, changes in state, contingency, etc. But the papers in this issue - writing and thinking about narratives in science - really pick away in special directions at these basic notions, and do something to subvert the basic ways of thinking that have inhabited discussions on this front in the literary domain.

Consider first b), the chronicle issue. The narratological literature takes the difference between a chronicle and a narrative to be that a narrative offers relational elements that join together a sequence of events, whereas a chronicle just lists them. This immediately, in the scientific domain, moves the narrative into explanatory territory, both in the task of teasing apart and/or putting together the

causal or implied causal relations between events in the narrative, and in making some sense of this in scientific terms. Thus the once-common idea that narratives cannot explain is problematic from the start (Roth, Beatty, this issue). Of course this is all grist to the mill of those who take working practice to be the basis of understanding and explanation - trying to figure how things fit together, how they relate, what effect some cause might have, what cause might have produced this effect. We see this in several papers. What set of conditions add together to constitute (create?) a particular medical condition (Hurwitz, this issue)? Which set of actions lead to confrontations in international relations and which ones resolve them? Which causal mechanism - with its elements, organisations, and emergent capacities, creates (or does not) an outcome? And is the abstract skeletal mechanism sufficient in its bare bones to give a credible account or do we need not just the skeleton but the flesh that creates the full narrative to make it a viable account? (Crasnow, this issue)

How about a), temporality itself? Narratives tell stories over time, don't they? Maybe, but it is at least not obvious what kinds of time. Some scientific narratives of course do happen to hook onto real time events, the regular repeating developmental narratives of the animal and plant kingdoms, the long durée narratives of evolution, the extremely fast narratives of chemical bonding. But we already suggested with respect to the relation of mathematical models and narrative, that some scientific narratives tell of events in the logical time of the model: when event A is causally related to a subsequent collection of events B, C, D etc., those relations define the sequence, and there is no time unit attached to those sequences that prompt the narratives, thus the notion of 'logical time' (see Klein 1997). These narratives might include possibilities, probabilities, and contingencies, but still be in some non-real time frame. The fact that narratives may not hook onto time, but do require attention to relationships suggests already that what might be critical to the notion of narrative is not time, but ordering (Morgan, this issue). Such ordering

could be that of the causal (or logical) ordering of a mechanism-based narrative, it could be a pragmatic narrative ordering based on time, but it could even be a non-time, non-logical, ordering. The interleaving elements of a culture need to be ordered to create that tapestry that is narrated, but there is often no relevant time - real or logical - that will provide that ordering to show how the elements in that culture relate and how to narrate their interrelations.

6. Narrators and narrated

If science has narratives, it must also have narrators. One of the hallmarks of modern science is thought to be an attachment to objectivity, yet in some sciences the scientist presents her or himself as narrator. Is there a fundamental difference between sites of science where the scientist is present only as an impersonal narrator and those where he or she is also an actor in the narrative? Whereas it might seem that the demands for scientific credibility would always require a suitably scientific style of detachment – stereotypically writing in the third person passive voice to make nature seem to speak for itself – this goal is by no means always warranted. Scientists are present in their narrative whenever they act in it, and the narrative would make no sense if they were written out – they appear in medical case narratives of diagnosis or treatment (Hurwitz, this issue), or natural historical narratives where scientists are experimenters rather than just observers (Terrall, this issue), that is, when they 'don't just peer, interfere!' (Hacking, 1983). But there is another site where narrators are habitually present - that of anthropological work and social science case studies in live time. Here the scientist is present playing a dual role, both as a confused but reflective participant, and then if/when confusion is resolved, as the narrator throwing explanatory light on the situation (Morgan, this issue). Similarly, those social scientists who place themselves firmly in their narratives inevitably produce accounts that embed autobiographical elements. This participant-narrator is not just a community preference, rather such

presence gives the investigator space to establish their credibility and serve to let the reader in as a vicarious 'witness' to their field work. There is also an historical point here: whereas natural historians routinely appeared in their narratives in the 18th and 19th centuries, they are more likely to be absent in 20th century papers. Similarly, while in some medical case narratives, or in some periods of such narrative accounts, the medical scientist or professional might adopt a detached position (appearing only briefly in a metaphorically anonymous white coat), in others their presence is used to allow them to convey a sense of unpredictability, or surprise, or difficulty about their account of the case at hand.

The presence or absence of scientists in their narratives has particular importance for the literary quality of the narrative, which too plays a part. While some medical narratives adopt the detective novel genre of following clues, others are more like suspense stories, and genres of fictional writing might be shamelessly evoked not just in titles but in styles of writing, such as recounted by Hurwitz in 'the case of the nail in the boot' (this issue). But the conscious adoptions of style and genre are not limited to those cases of the human sciences where there is an interaction between scientist and human patient. Narratives of the vicious behaviour of ant-lions in capturing innocent lesser insects, inflicting violent death against the valiant struggles of the prey are horror stories indeed, particularly where the prey insect is eaten alive while they still struggle. But these horrors are almost matched by the violent terms used by scientists to describe their own experimental procedures and interventions - seizing their insect subjects, cutting off their limbs, throwing them into various liquids, and watching their tortures. Such vigorous narrative accounts, stressing the active participation of the scientist, enable the community to be a virtual witness to the experimental activities much as the anthropologists let readers experience their field work.

7. Explanation and Understanding

Terrall's natural historical scientists regularly construct narratives which provide accounts of the behaviour of their phenomena that have some generality. For example, ant-lions are shown to behave consistently, and narratives of those consistent behaviour patterns reflect the scientists' explanations and understandings of the behaviours. And regardless of whether the scientist is explicitly or implicitly the narrator, the evidence of the papers in this special issue suggests that their narratives provide explanations or understanding that have potentially broader writ for those scientists who use them. Yet these broader characteristics and usages of such narrative explanations appear hard to pin down. Crasnow argues that narratives provide more coherent explanations for their users than simple mechanistic accounts of, for example, why democracies don't go to war; Rosales focuses on how narratives provide a more joined up explanation of distinct processes in evolution; and Morgan suggests the conceptual elements of narratives provide the vehicles for re-situating explanations elsewhere. In these three accounts, narratives can be used to explain particular cases, but it is equally so that those narrative accounts may be taken by the scientists concerned to be generically applicable to similar situations and contexts in their fields. What counts as explanation, and understanding, within a science depends less on a universal ideal, than on what satisfies the scientific norms and values and shared knowledge set of a community. The scientist as narrator - constructing a narrative of a particular sort, aimed at reaching an audience of other scientists within a particular context - sits at the centre of such scientific activity. All of the papers in our special issue reinforce this basic point and strive to make clear its significance for scientific knowledge.

Community practices and values, and the presence of the scientists themselves interacting with the objects and subjects of their science, are elements that have recently become prominent in discussions about the relation between understanding

and explanation offered by de Regt et al (2009).[2] Philosophers of science have traditionally treated understanding as something that follows from explanation. Explanation itself, since the decline of the Hempelian deductive-nomological view in the 1970s, has been based variously on unifying theory, or more narrowly on causal mechanisms, or more pragmatically on answers to why questions. All of these approaches remain important, but particularly relevant for us here is the pragmatic view, in which explanation is understood to be context dependent. Giving credence to context and to community (first and foremost the scientists themselves and their community, but more broadly the various publics who interact with and use science) is consistent with renewed attention to understanding as a category much broader than explanation. Understanding emerges in this recent work as supplying some of the things that were previously thought to depend on explanation, but might now be thought to emerge from scientific practice and experience: knowledge of causal connections, necessity, possibility, even unification.

It may be immediately apparent that this broader conception of the relation of understanding to explanation needs to incorporate the role of narrative, even calls out for it. If the practices of narrative are to be added to this account of understanding, the first thing to note is that these practices are far more various than one might suppose. Narrative does not just exist in the spoken word or text, it exists in the combination of words, diagrams, videos, pictures, and labels and notes. It does not just consist in a joined up beginning-middle-end account, but in the exacting narrative description of the behaviours of an organism which has eluded categorization (Terrall), or in the possibilities of successive re-description until a diagnostic answer to a problem is found (Hurwitz), or out of successive simulation runs of a model until understanding and insight are gained (Wise), or even in answering questions which seem unanswerable to begin with (Morgan). While narrative practices differ radically across the many sciences, the endemic if not

[2] The following remarks draw on the editors' introductory essay, "Focusing on Scientific Understanding," in de

chronic use of narrative in science and its regular recurrence speak to the possibilities of what we like to call 'narrative knowing': accounts of phenomena that can only be known, or be best known, via narrative. According to the papers in this special issue, narrative knowing is most relevant when the scientific phenomena involve complexity, variety, and contingency, and when materials need to be carefully ordered in relation to one another or to time for their implications to be understood and their behaviours explained. But this list of the types of places where narrative knowing may occur is only a starting point, for further and wider study is needed to tease apart the relation of scientific understanding to narrative knowing.

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